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(54) Rotary ball valves and ball joints

(57) A seal for a rotary ball valve or ball joint comprises a rigid backing ring (12) adapted to fit snugly in a recessed part of a housing (1) and having a curved surface (13) complementary to the surface of the ball (2), the curved surface (13) being formed with grooves (14) concentric with the ring axis with one at least of the grooves (14) containing a resilient ring (15) adapted to engage the ball (2), the backing ring (12) being formed adjacent its back face, with a radially directed annular slot 16') so as to impart some resilience to part of the back face, there being bonded to the said resilient back part a soft annular gasket (18').

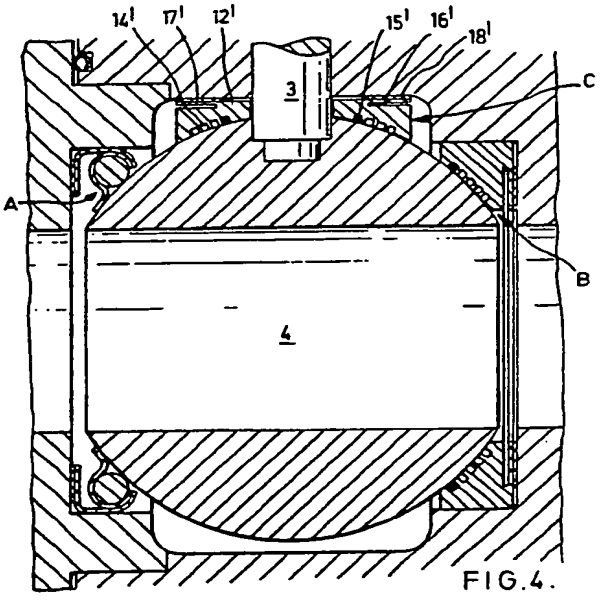

FIG.4.

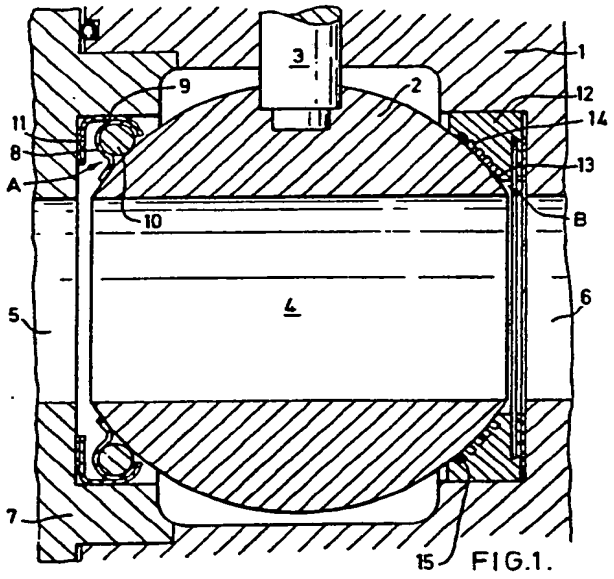

FIG.1.

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The drawing(s) originally filed was (were) informal and the print here reproduced is taken from a later filed formal copy.

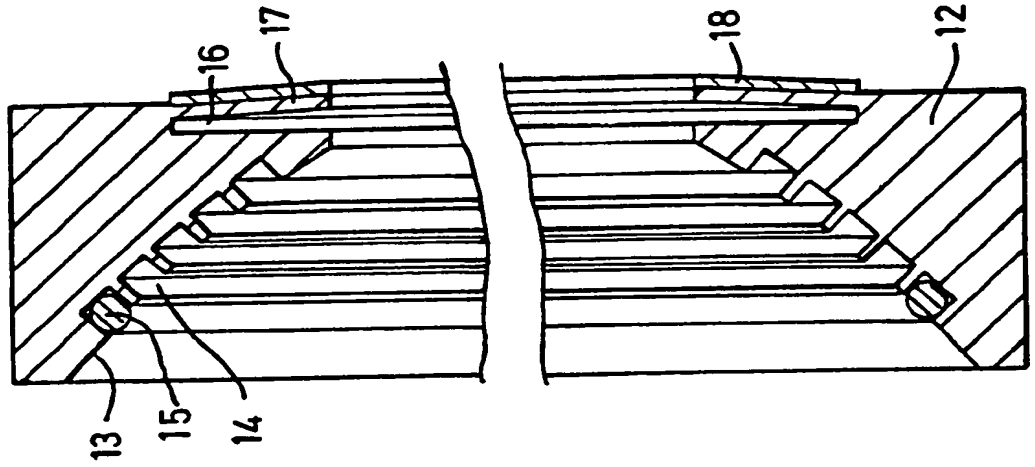

FIG. 2.

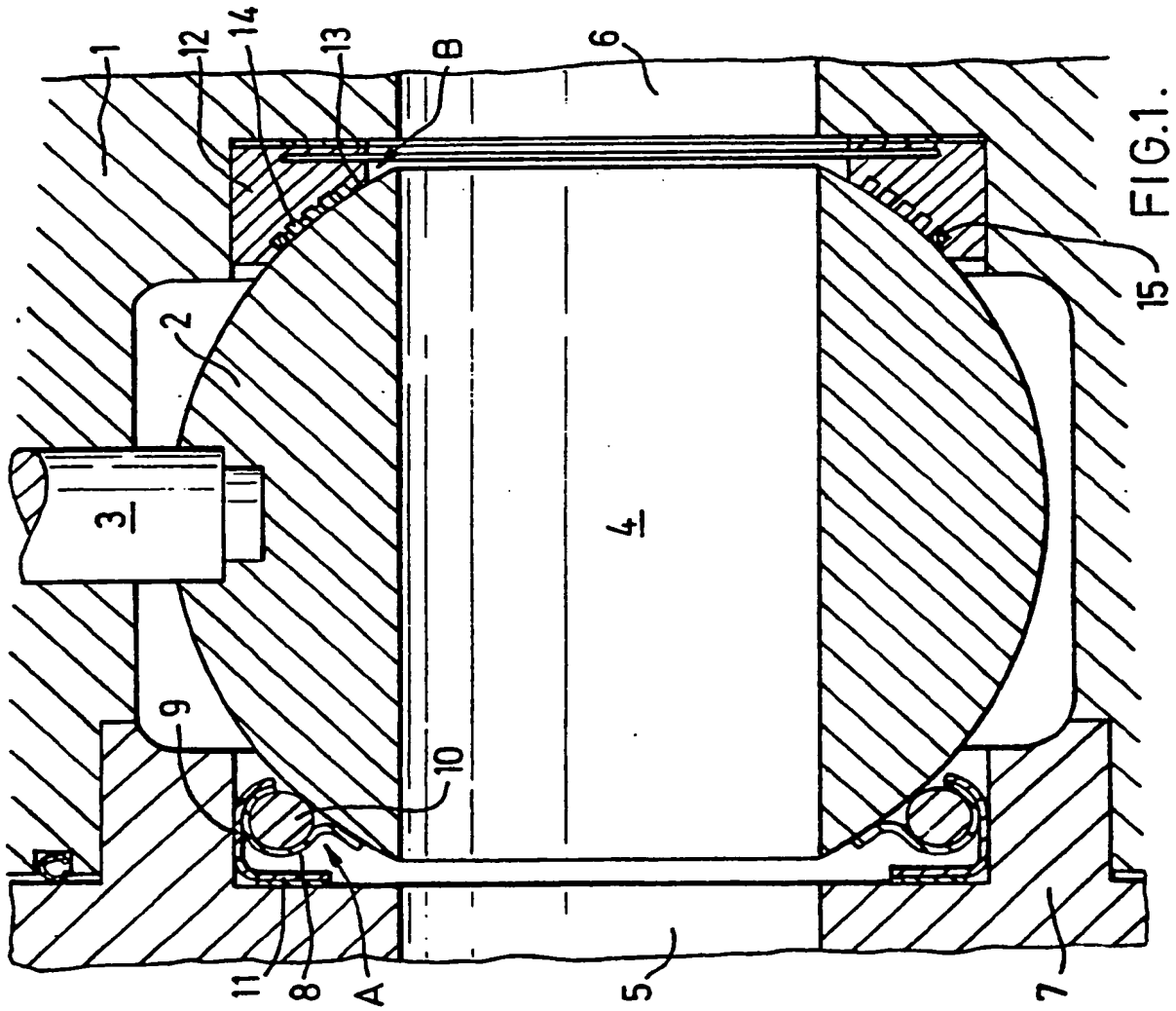

FIG. 1.

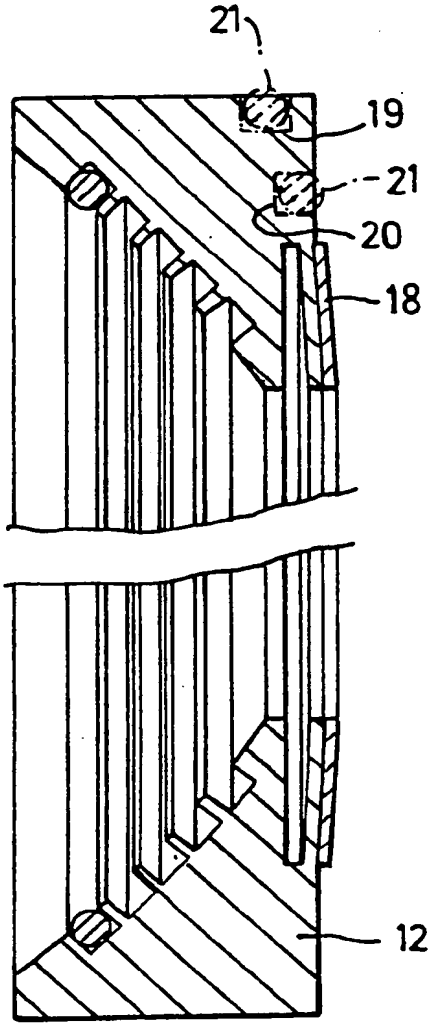

FIG.3.

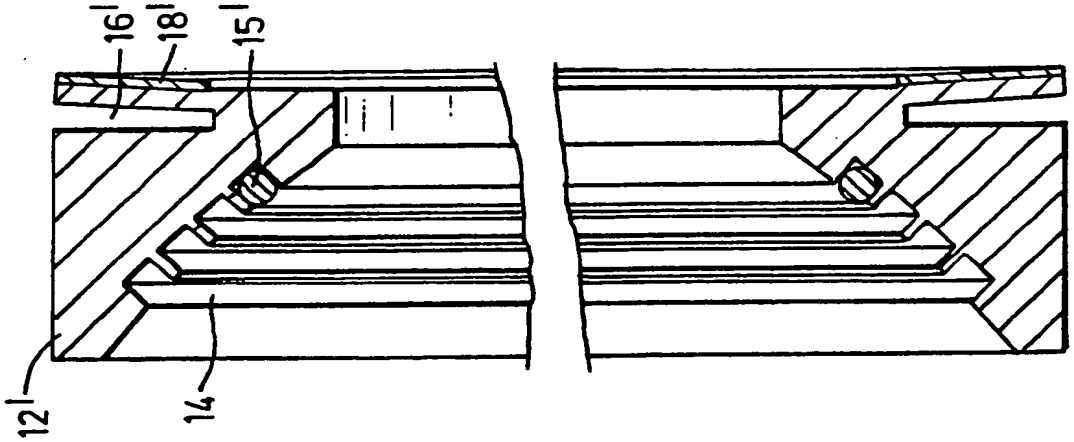

FIG.5.

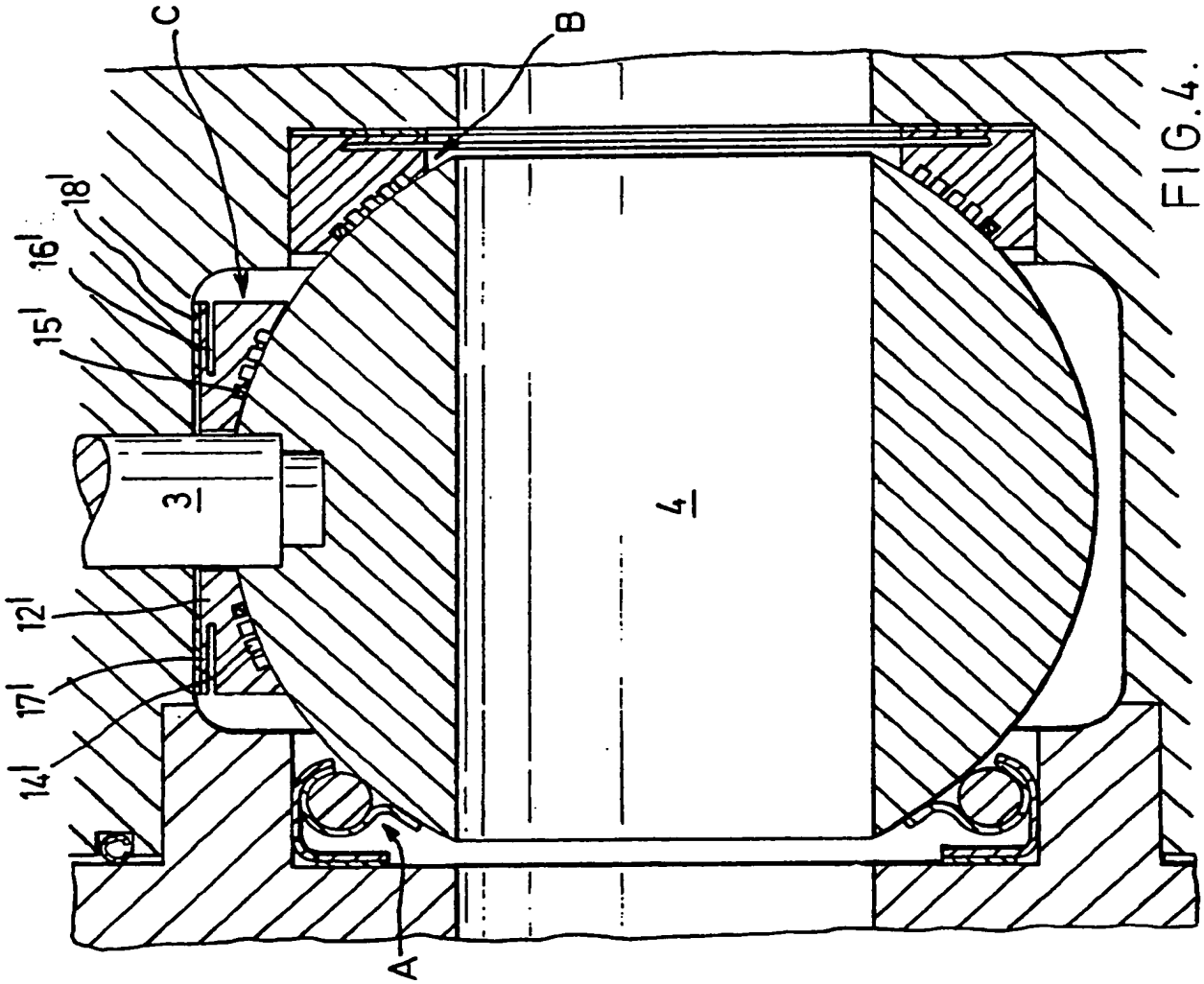

FIG.4.

"IMPROVEMENTS RELATING TO ROTARY BALL VALVES AND BALL JOINTS"

This invention relates primarily to rotary ball valves for controlling the flow of fluids through pipes and bores, and more particularly to the provision of annular seals between the ball valve housing and the valve ball thereof. The invention is however also applicable to rotary ball joints.

Such seals are manufactured inter alia from low friction materials such as PTFE and although these have been extremely successful they have the disadvantage of low fire resistance and resulting disintegration of the low friction material. Attempts to protect the seals by the use of metal diaphragms and other expedients have however not met with much success.

With the general object of overcoming the above mentioned disadvantage there has already been proposed, in accordance with British patent application 8620489, a composite annular seal for a rotary ball valve or ball joint having certain particular characteristics. A ball joint of this kind can be used on both the upstream and the down stream sides of the ball, as is essential when the direction of fluid flow can be in either direction, when the pressures involved are moderate.

However when extremely high pressures, of the order of 1,000, 5,000, 10,000, 25,000 lbs. per square inch are involved, and are uni-directional only, the above mentioned seal is only suitable for sealing the inlet side of the ball valve and for the outlet there must be some other form of seal which in operation is capable of accepting the enormous load to which the ball valve is subjected when it is in its closure position.

The present invention has been devised with the object of providing a rotary ball valve seal which functions efficiently in the above mentioned conditions.

In accordance with the present invention therefore, a rotary ball valve seal comprises a rigid backing ring adapted to fit snugly in a recessed part of a ball valve housing and having a curved surface complementary to the surface of the ball. This backing ring is characterised firstly in that the curved surface is formed with a series of grooves which are concentric with the axis of the backing ring with one at least of the grooves containing a ring of resilient material adapted to engage the ball, secondly in that the backing ring is formed adjacent its back face, with a radially directed annular slot which is so dimensioned and disposed as to impart some resilience to part of the back face; and thirdly in that there is bonded to the said resilient back part of the backing ring an annular gasket made of soft material.

Preferably the concentric grooves are of rectangular profile and any one only, for instance the radially innermost or the radially outermost of them, may contain the ring of resilient material.

Also the resilient back face part, to which the soft gasket is bonded, may be the radially innermost or radially outermost part of the back face of the ring.

The nature of the invention and its advantages over prior art will however be explained in greater detail by reference to the accompanying drawings, in which:

Fig. 1 is an axial section of a rotary ball valve;

Fig. 2 is a section on an enlarged scale of the right hand ball valve seal which is illustrated in Fig. 1;

Fig. 3 is an enlarged scale axial section of a modified version of ball valve seal from that shown in Figs. 1 and 2;

Fig. 4 is a view, similar to Fig. 1, to illustrate the mode of use of a modified form of ball valve seal according to the invention;

Fig. 5 is an enlarged scale view of a second ball valve seal shown in Fig. 4; which also shows a modification thereof.

Referring now to the drawings, the rotary ball valve illustrated in Fig. 1 consists of a main housing 1 containing the valve ball 2 which can be turned by means of the attached shaft 3 between positions in which its central bore 4 is either aligned with, as shown, or at right angles to, a fluid flow inlet opening 5 and a co-axial fluid flow outlet opening 6.

On the fluid flow inlet side of the valve ball 2 there is a sealing ring assembly A which is held in place by a backing plate 7 and is constructed substantially as described in co-pending British patent application 8620489. It essentially comprises two pressed metal rings 8 and 9, a sealing ring 10 made of P.T.F.E. or similar low friction material and a relatively thin ring 11 made of a soft resilient gasket material such as expanded graphite.

A suitable material for the soft resilient gasket is compressed asbestos fibres or synthetic fibres bonded into sheet form with, for example, nitrile or butyl rubber. Alternatively, where higher temperatures are likely to be encountered the soft resilient gasket material could be expanded graphite sheet.

On the outlet side of the rotary ball valve there is provided a seal B in accordance with the present invention.

This seal B comprises a rigid backing ring 12 made of metal and machined from a bar, tube or a casting. It is machined to dimensions which enable it to fit snugly in a recess in the valve housing 1 and it is formed with a curved surface 13 which is complementary to the surface of the ball 2.

It may be mentioned here that there are currently commercially available a number of somewhat similar sealing rings which are however machined from solid P.T.F.E. or moulded expanded graphite. However these rings suffer from the following two major shortcomings:

1. Especially in the off-shore oil industry where there is invariably a substantial amount of sand in the oil, once the sand gets between the ball and the seal it very quickly puts deep score marks across the seat and this results in serious leakage.

2. Because of the complete lack of flexibility of the sealing rings in high pressure oil/gas applications wear occurs very quickly owing to friction between the ball and the seal and this leads to serious leakage.

Reverting to Fig. 1 and also referring to Fig. 2, it is to be noted that the curved face of the backing ring is formed with a series of five rectangular profile grooves 14 which are concentric with the axis of the backing ring. These grooves have two functions namely:-

Firstly, in the event that sand or any other foreign bodies in the fluid which is under pressure should intrude between the ball and seal there is the opportunity, during the opening and closing of the valve, by the wiping effect on the ball during rotation, for the foreign bodies to be carried into any one of the grooves 14 without exerting a scoring action right across the sealing face 13. Otherwise expressed, there can be said to be a cavity or receptacle into which foreign matter can be swept.

Secondly, if the valve is controlling the flow of a gas, the grooves function in the manner of a labyrinth seal whereby a pressure drop occurs across each groove, and this contributes to the formation of a near perfect seal.

As shown, there is located in the largest diameter groove 14 an 'O' ring 15 which is made of P.T.F.E. or Elastomeric material. The presence of this ring creates the virtually perfect fluid type seal which is so critical in cryogenic and highly volatile applications.

It is important that the seal for the present purpose should possess a degree of flexibility and this is particularly the case when a valve has to be opened and closed as many as say, 100,000 times a year. Notwithstanding the use of coatings of low friction material applied to the ball and the complementary face of the sealing assembly, wear does occur and has been a problem particularly so far as existing sealing arrangements, which partially or totally lack flexibility, are concerned. In this connection it is not true to say that facings of P.T.F.E. solve the problem which is very serious when sand is present in the fluid being handled. Also the exclusive use of a P.T.F.E. coating, owing to temperature limitations, does not contribute to a so-called "fire-safe" seal.

In order to achieve flexibility in the seal of the present invention there is machined into the backing ring 12 near its rear face a narrow radially directed annular slot 16.

As machined, the sides of the slot 16 are parallel with each other and with the rear face of the backing ring. However after this machining operation the ring 12 is transferred to a rolling machine wherein a tapered roller enlarges the entrance of the slot 16 and in so doing causes formation of a rearward angled wall or fin

17 which imparts some resilience to the radially innermost part of the rear face of the ring 12.

There is then bonded to the rearward side of the fin 17 a gasket 18 made of soft material, whereafter the curved face 13 of the ring is coated with a low friction co-efficient material such as P.T.F.E., Electroless Nickel, Molybdenum disulphide or one of the many proprietary coatings which are readily available..

After this operation, the 'O' ring 15 of P.T.F.E. or like material is fitted in the radially outermost groove 14. There is thus provided a load-bearing, flexible seal which is both self-energising and safe. As can be seen from Fig. 1 the seal is dimensioned to fit snugly in the housing and when the ball is in the closed position the total load is carried by the flat radially outward part of the rear face of the ring 12.

However in operation a different phenomenon occurs and this is achieved by the fin 17 to which the soft gasket 18 is bonded.

The purpose of the gasket 18 is to prevent any possible leakage between the seal and the housing. At the same time, the fin 17 acts as a spring to press the seal firmly against the ball and maintain perfect contact at all times. The load on the ball and the

housing is further enhanced by the self-energising effect of pressurised fluid entering the slot 16 which presses the faces of the ring 12 more firmly than ever against the housing and the ball 2 - all of which enhances the sealing performance of the valve. These seals have been manufactured in phosphor bronze, mild steel and stainless steel for evaluation purposes and have performed perfectly under the most adverse conditions.

Fig. 3 illustrates how an even more enhanced sealing effect can be achieved, in addition to the use of a soft gasket 14, by providing a groove 19 in the circumferential surface of the ring 12 or alternatively by providing a groove 20 in the radially outer part of the back face of the ring 12, in each instance the groove being occupied by an 'O' ring 21 made of P.T.F.E. or Elastomeric material.

In Fig. 4 there is illustrated a ball valve sealing arrangement incorporating a composite seal A and a seal B as already described with reference to Figs. 1 and 2, and also provided with a seal C which surrounds and seals the operating shaft from the fluid whose flow is being controlled. This seal C is similar in construction to the seal B except that an annular slot 16' and a resultant fin 17' are disposed at the radially outward part of the ring 12' and the 'O' ring 15' is

situated in the radially innermost rectangular profile groove 14' in the curved surface of the backing ring 12'. The effect of this arrangement is that the shaft is completely sealed and cannot be reached by the fluid which is being controlled by the valve. This is regardless of whether the ball is floating freely or trunnion mounted.

In all instances the thickness of the fin and its angle in relation to the remainder of the back face of the ring is calculated to suit the desired loading between the ball and the housing.

It is to be understood that if required a seal in accordance with the invention can also be used on the upstream side of the ball, that is to say for instance instead of the seal A shown in Fig. 1.

It is also to be understood that a seal in accordance with the invention may also be utilised for the sealing of a ball and socket joint.

CLAIMS

1. A rotary ball valve seal comprising a rigid backing ring adapted to fit snugly in a recessed part of a ball valve housing and having a curved surface complementary to the surface of the ball, characterised firstly in that the curved surface is formed with a series of grooves which are concentric with the axis of the backing ring with one at least of the grooves containing a ring of resilient material adapted to engage the ball, secondly in that the backing ring is formed adjacent its back face, with a radially directed annular slot which is so dimensioned and disposed as to impart some resilience to part of the back face; and thirdly in that there is bonded to the said resilient back part of the backing ring an annular gasket made of soft material.

2. A rotary ball valve seal in accordance with Claim 1 wherein the said grooves are of rectangular profile.

3. A rotary ball valve seal in accordance with Claim 1 or Claim 2 wherein there is a single said 'O' ring which is located in the radially outermost one of said grooves.

4. A rotary ball valve seal in accordance with Claim 1 or Claim 2 wherein a single said 'O' ring is located in a radially innermost one of said grooves.

5. A rotary ball valve seal in accordance with any of Claims 1 to 4 in which said resilient back face part and said gasket are located at the radially innermost part of the ring.

6. A rotary ball valve seal in accordance with any of Claims 1 to 4 in which said resilient face part and said gasket are located at the radially outermost part of the back of the ring.

7. A rotary ball valve seal in accordance with any of Claims 1 to 6 in which the circumferential part of the ring adjacent the back face of the ring is formed with a radially outwardly facing groove which contains an 'O' ring of resilient material.

8. A rotary ball valve seal in accordance with any of Claims 1 to 6 in which there opens into the back face of the ring a groove which contains an 'O' ring.

9. A rotary ball valve seal in accordance with any of Claims 1 to 8 which concentrically surrounds a shaft by which the valve ball is supported or rotated.

10. A ball joint incorporating a seal as claimed in any of the preceding claims.

11. A rotary ball valve seal constructed and adapted to operate substantially as hereinbefore described with reference to and as shown in any of Figs. 1 to 5 of the accompanying drawings.

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